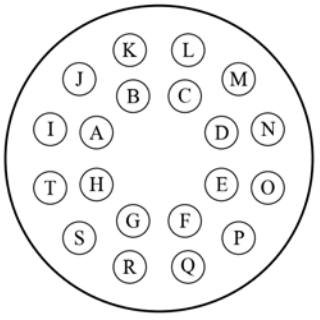
scans were made (120 kV, 250 mAs). In the first scan, the phantom contained only Solid Water rods. This scan was reconstructed without O-MAR to obtain a baseline. In the second scan, rod H was replaced with a titanium rod to simulate a patient with a unilateral metallic hip prosthesis. For the third scan, also rod E was replaced with a titanium rod to simulate a patient with bilateral metallic hip prostheses. Both the second and third scan were reconstructed with O-MAR. In each of the three reconstructions, cylindrical VOIs (d = 20 mm, l = 42 mm, approx. 6400 pixels) were created in each rod using ProSoma 3.3 (MedCom GmbH, Darmstadt, Germany). Subsequently, the mean CT number and the standard deviation were determined in each VOI. With a t-test, it was assessed whether the mean CT numbers obtained from each VOI in the reconstructions of the patient simulations differed significantly ($p < 0.01$) from the baseline values.



Results: In the unilateral simulation, the mean CT number in 10 of the 19 VOIs was significantly different. However, all differences were small (range: -2.4 to +2.3 HU) and therefore not considered of clinical relevance. In the bilateral simulation, the mean CT number in 13 of the 18 VOIs was significantly different. Apart from rods O and T, the differences were small (range: -2.0 to +11.8 HU) and therefore not clinically relevant. In rods O and T, the difference was respectively -32.5 and -31.5 HU. Although relatively big, these differences are also not clinically relevant as in our external beam radiotherapy planning department, beam setups in which a beam enters the PTV through a metallic implant are always avoided.
Conclusions: Our phantom study shows that the CT numbers in O-MAR reconstructions of the pelvic area that contain large metal objects are accurate enough for clinical use in external beam radiotherapy treatment planning.

ELECTRONIC POSTER: PHYSICS TRACK: IMPLEMENTATION OF TECHNOLOGY, TECHNIQUES, CLINICAL PROTOCOLS OR TRIALS

EP-1298
Evaluation of dosimetric and geometric stability of a new digital linear accelerator over a period of 3 years
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Purpose/Objective: In September 2009 the newly designed digital linear accelerator TrueBeam STx (Varian Medical Systems) was installed. Over the last three years constancy tests were performed to evaluate the stability of this machine.
Materials and Methods: The linear accelerator is equipped with two flattened and two flattening filter free beams of nominal energy 6 MV and 10 MV. As of November 2009, the output was checked daily using a PTW LinaCheck device; and since March 2010, energy and symmetry were checked weekly using a PTW QuickCheck device. IsoCal verification, a method to quantify deviation from the kV and MV imaging isocenters to the treatment isocenter and to determine gantry isocenter instabilities, was performed on a daily basis. For comparison, a weekly kV isocenter check using a cube with an internal metal ball, and monthly gantry starshots were performed. The performance of the high definition multi leaf collimator (HD MLC) was tested initially on a weekly basis. More recently the frequency was changed to daily. MLC performance was verified using Picket Fence tests and by analysing trajectory logfiles.
Results: During the first two years the output increased by 0.3 % per month, after which the output became stable. Variation in symmetry was larger for FFF beams compared to flattened beams due to the high sensitivity of FFF beam symmetry on the detector array setup. The symmetry of the flattened beams drifted by approximately 1% and had to be adjusted in June 2012. No drift was observed for the FFF beams. The two imaging isocenters have never differed by more than 0.4 mm from the treatment isocenter. There exists no recommendation for the frequency of MLC initialisation. Our analysis of the daily Picket Fence test showed that initialisation should be done on a weekly basis and Picket Fence test on a daily basis. It occurred four times during the three-year period, that one of the MLC leafs had a positioning discrepancy of between 1-2 mm. This was detected in the morning by the Picket Fence test. The error was not detected as an interlock by the linear accelerator (linac) nor recorded in the trajectory logfiles. Trajectory logfiles only record the primary and not the secondary readout. Therefore QA based only on trajectory logfiles is not sufficient.
Conclusions: It is important to perform extended QA for linacs which are new on the market, to evaluate their weaknesses and strengths. In our opinion the strength of the TrueBeam is the high precision of the imaging system; a weakness being the stability of the monitor chamber and the design of the HDMLC. An interlock for the MLC is only triggered if the deviation between the primary and secondary position is larger than 2.5 mm. We have experienced a slight drift of the flattening filter with time, which altered the symmetry of the flattened beams.

EP-1299
Various preclinical studies using image-guided small animal irradiators
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Purpose/Objective: The experience on the image-guided preclinical studies, conducted on two dedicated kilovoltage small animal irradiators, are to be presented (XRad-320 and XRad-225Cx, Precision X-Ray Inc., North Branford, CT).
Materials and Methods: Two platforms of preclinical stereotactic irradiator are used, which are capable of delivering high dose, high dose-gradient small field (circular, square, and custom shape) irradiation utilizing a x-ray image guidance system. The XRad-320 is composed of a fixed radiation source and a computer-controlled 2D localization system. In contrast, the XRad-225Cx can deliver multi-angle beams with 3D localization based on a built-in cone-beam computed tomography. The basic science experiments performed on two systems are: hemibrain irradiation utilizing a custom D-shape collimator to examine the genetic basis for radioresistance in glioblastoma; a single fraction of 10 Gy whole brain irradiation using a 10 mm circular collimator to study the association of drug addiction with hippocampal neurogenesis; 90 Gy single fraction irradiation using 1 - 5 mm collimators to study the response of normal lung; orthotopic lung and prostate tumor treatment in rats using high dose stereotactic irradiation; 16 Gy single fraction irradiation of age-related macular degeneration with the application of anti-phosphatidylserine (anti-PS) antibodies in a mouse model; a single fraction dose escalation to study the effects of stem cell enhanced fat grafts to mitigate cutaneous radiation injury. Various preclinical imaging modalities (MRI, ultrasonography, bioluminescence imaging) are used to aid in planning and/or response assessment.
Results: Hemibrain study showed that the loss of conditional p53 and PTEN genes, alone or in combination could result in radioresistance in an actively dividing population in the brain. The whole brain irradiation study in animal model indicated that the suppression of neurogenesis in adult hippocampus enhanced vulnerability with a variety of drug addictions and its relapse. In normal lung of rats, the obliteration of alveoli, hyperplasia of the bronchiolar epithelium, and small inflammatory of cells were observed in response to small high dose irradiation. Orthotopic tumors are dramatically in size and their activity are effectively suppressed compared to control groups. Preliminary data indicated that anti-PS antibodies with radiation have a potentiating effect in blocking choroidal neovascularization. Ulceration occurred on all irradiated skin of various doses within 10 days post irradiation. Peak ulceration was weakly correlated with doses, while average ulceration presented a stronger correlation.
Conclusions: The radiation effects in various preclinical small animal models were successfully studied.

EP-1300
Introduction of SagittiltÆ prone breast board into daily practice: From pre-clinical to first clinical experiences
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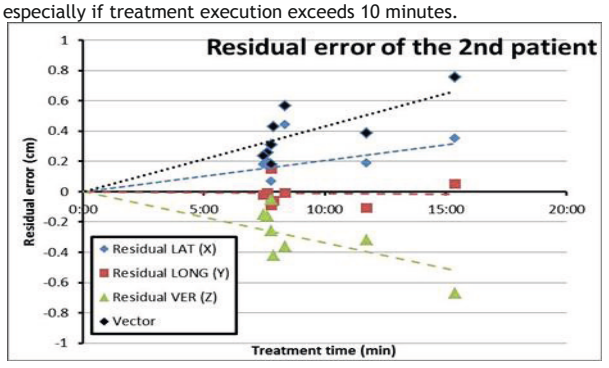
Purpose/Objective: To investigate the advantages in dosimetry, patient comfort and positioning accuracy when using the newly developed Sagittilt® (Orfit Industries, Wijnegem, Belgium) prone breast board.
Materials and Methods: A careful clinical introduction of Sagittilt® has been initiated: Phase 1: pre-clinical treatment planning study and Phase 2: prospective clinical trial (still ongoing). During the pre-clinical phase, 14 patients with breast cancer were scanned in supine and prone position and treatment plans were created to investigate dosimetrical advantages of Sagittilt®. The second phase started with the clinical treatments of (to date) 5 patients in prone position. This early clinical phase focused on patient comfort assessed by an in-house developed questionnaire completed by the patients. Positioning accuracy has been assessed by daily online cone-beam CT acquisition (pre-RT CBCT), followed by a post-RT CBCT in order to investigate stability of positioning over time.
Results: The pre-clinical treatment planning study confirmed non-significant differences on target coverage (V95%-107% of the PTV) and on heart dose, while a significant reduction of the ipsilateral lung and slightly higher dose to the contralateral breast were observed. The early clinical phase eliminated the increased contralateral breast dose, revealed good-excellent patient comfort, while the setup error remained low (individual systematic and random errors were: 0-3 mm and 0.8-2.5 mm). The residual error (ie. the error observed between the two CBCT) could rise up to 7 mm (at the 2nd patient Figure 1.) especially if treatment execution exceeds 10 minutes.



Conclusions: Our methodology for the clinical introduction of Sagittilt® proved to be safe. Our current data showed promising results for dosimetry and positioning accuracy. Special attention should be paid to reduce the overall treatment time to keep residual error as low as possible.

EP-1301
Orthanc - lightweight, scriptable DICOM server for medical image management in radiotherapy
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Purpose/Objective: High-quality radiotherapy (RT) treatment planning requires the combination of information arising from multiple medical imaging modalities. For this reason, RT implies the setup and the management of complex flows of images between the various modalities and software of the hospital. Even though biomedical images are most commonly stored and transferred using the DICOM standard, it remains hard to automatize and optimize these clinical flows that are very specific to each hospital. This stems from the fact that programming the DICOM network protocol requires both a high level of familiarity with the DICOM standard as well as substantial experience in computer programming. This motivates the introduction of the Orthanc software in the medical practice to improve the RT imaging workflow.
Materials and Methods: Orthanc is an open-source, easy-to-use, lightweight and scriptable DICOM store. It takes advantage of the DCMTK toolkit for powerful DICOM handling abilities. Multiple instances of Orthanc can be easily and freely deployed in the hospital network. Orthanc comes bundled with an embedded Web interface that allows the end-users to browse and interact with the content of the DICOM store from any computer. Orthanc can be setup as a bridge between multiple DICOM modalities, which improves the interoperability between proprietary systems by decoupling them. Furthermore, Orthanc features a rich scripting environment: It can be driven from any computer language to automate and optimize clinical processes. Orthanc is written in C++ for maximum speed, and emphasis is put on the quality and the automated validation of its source code.
Results: Orthanc is currently used in our Institution to improve two real-world clinical processes. Firstly, Orthanc is deployed as a buffer for PET scans between Nuclear Medicine (NM) and RT departments. These images are indeed systematically purged from the Treatment Planning System (TPS) on a daily basis. Orthanc enables the RT physicists to immediately find the purged images and restore them back from Orthanc into the TPS on the fly, without any interaction with the NM team, hence accelerating the clinical processes. Secondly, another instance of Orthanc is configured to gather the in-room images that are produced during the RT treatments. This opens the path to the automated assessment of the quality of the patient positioning and to the clinical research about adaptive radiotherapy in our hospital.
Conclusions: The open-source Orthanc software provides medical physicists with a powerful environment to make the image flows more robust and automated in RT departments.

EP-1302
SBRT in prostate cancer: is CyberKnife the only option?
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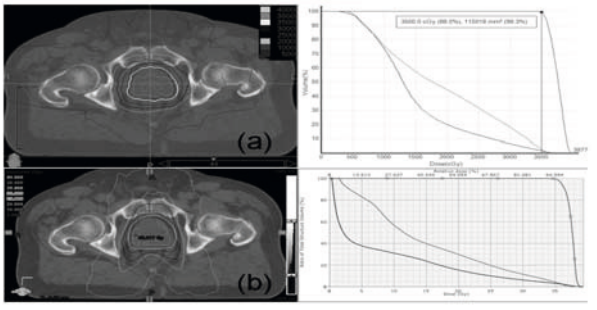
Purpose/Objective: Over recent years, there has been an increasing interest in the use of stereotactic body radiotherapy (SBRT) in the management of low and intermediate risk prostate adenocarcinoma. A number of small studies and single centre series have been published demonstrating biochemical progression free survival rates (bPFS) at 3 to 4 years between 90% - 100%, with long term grade 3 rectal and urinary toxicity no higher than 3%. The majority of these series have used Cyberknife™ (Accuray Inc., Sunnyvale, CA) with an international randomised controlled study underway, comparing SBRT delivered using Cyberknife, to surgery and to conventionally fractionated intensity modulated radiotherapy.
Materials and Methods: Six patients previously treated with conventional radical radiotherapy were selected to represent a typical range of prostate shapes and sizes. Delineation of the prostate alone (CTV) and all organs at risk (OARs) was performed by one consultant clinical oncologist. A margin of 3mm for CyberKnife and 5mm for Rapicarc were used to create PTVs. Plans that deliver at least 35Gy in 5 fractions to at least 99% of the PTV (PTV35Gy>99%) were then created using Accuray Multiplan v.4.5 (Ray-tracing algorithm) and Varian Eclipse v.10 (AAA algorithm). SBRT dose constraints that are typically employed were used to optimise doses to the rectum and bladder without compromising PTV coverage (Rectum V18 <50%, V28 <20% and V36 <1cc; bladder V18 <40%, V37 <10cc). Plans were transferred to a water equivalent phantom and delivered doses were measured for both systems using radiochromic film.
Results: Both planning systems achieved a planned dose PTV heterogeneity of <13% in all six patients. The planned OAR constraints were achieved for all patients for both systems. We aim to dose escalate using both platforms to assess which platform is first to fail the constraints. Figure 1 shows an example of comparison CyberKnife and Rapidarc plans for the same patient.

Figure 1. (a) Cyberknife plan (b) Rapidarc plan.



Conclusions: We have shown that in terms of both planned and delivered dosimetry, Rapidarc is comparable to Cyberknife in SBRT for prostate cancer. The additional benefit of arc therapy is the comparatively short delivery time. In addition there is both a larger availability of radiotherapy centres equipped to deliver arc therapy, and a larger number of arc capable machines within each centre. An international, platform independent, clinical trial is urgently required to confirm an equal clinical benefit with other platforms.